1993 AQUATIC MACROINVERTEBRATE AND HABITAT SURVEY:

THREEMILE CREEK

RAVALLI COUNTY, MONTANA

prepared for the

Montana Department of Health and Environmental Sciences

prepared by

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Summary

Recent land management practices in the Threemile Creek drainage have attempted to reduce sediment delivery to the stream and thus improve water quality and riparian/instream habitats. The success of these programs can be measured, in part, by monitoring biological and habitat conditions within the stream. To this end, habitat and aquatic macroinvertebrates were surveyed during August of 1990 and 1993.

During both years, biological integrity and habitat quality were highest in the upstream reach and declined in each downstream reach. In the lower reach (Wildlife refuge), overall stream and riparian habitat was marginal in 1990 but improved to sub-optimal in 1993. For both years, habitat was rated sub-optimal in the middle reach (Illinois Bench Rd) and optimal in the upstream reach (below USFS).

Biological integrity estimates indicated significant improvements between 1990 and 1993 in the lower and middle reaches of Threemile Creek. Using a general reference for Valley and Foothills streams, macroinvertebrate-based assessments indicated that, during 1990, biological integrity was moderately impaired in the lower reach, slightly impaired in the middle reach, and nonimpaired in the upper reach. Three years later, biological integrity was slightly impaired in the downstream reach and nonimpaired in the middle and upper reaches.

Additional biological analyses, base on internally derived reference criteria, provided a more refined and sensitive assessment of relative conditions in Threemile Creek. In the lower reach, biological integrity improved from 25% in 1990 to 55% in 1993. A similar improvement, from 33% to 65%, was documented in the middle reach. However, relative biological integrity declined in the upstream reach, from 96% in 1990 to 72% in 1993.

Biological and habitat assessments were generally in close agreement. Instream substrate diversity, stability and embeddedness appeared to be the primary factors influencing the benthic community and biological integrity in all reaches of Threemile Creek.

Introduction

Concern for riparian and aquatic resources have prompted a program to improve environmental conditions in the Threemile Creek drainage. Best Management Practices (BMPs) seek to reduce sediment delivery to the stream while improving riparian and instream habitats. The organisms living in these habitats reflect not only local environmental conditions, but the health of the entire watershed. Consequently, the success of this program can be measured by monitoring biological and habitat conditions within the stream. Rapid Bioassessment Protocols (RBP) provide a cost-effective analysis of a streams environmental health. This multiple-metric approach uses aquatic communities to evaluate water and habitat quality. When combined with habitat or other assessments, they can provide a diagnosis of environmental health and degradation. To this end, habitat and aquatic macroinvertebrates were surveyed in August, 1990 (Wisseman 1992) and in August, 1993.

The objectives of this report are to (1) provide a current assessment of overall biotic condition in Threemile Creek, (2) compare and contrast conditions at three sites in the stream, (3) describe the degree and probable causes of biological impairment at these sites, (4) document any changes in biological integrity and habitat condition between 1990 and 1993 and, (5) develop a baseline for future monitoring.

Rationale

Aquatic macroinvertebrate communities consist primarily of immature insects, including stoneflies (Plecoptera), caddisflies (Trichoptera), mayflies (Ephemeroptera), true flies (Diptera), beetles (Coleoptera) and others. These organisms are important components of aquatic ecosystems, and are the energy links between primary producers (algae), organic inputs to the stream, and fish. Macroinvertebrates are good indicators of environmental conditions due to their limited mobility, predictable associations with specific habitats, and differential tolerances to pollution. Evaluating the biological integrity of this assemblage can provide an assessment of environmental quality that can be used to identify limiting factors, for detecting impacts from physical alterations, sediment deposition,

nutrients and toxicants, and to document successful mitigation of environmental degradation. Biological integrity is defined as "the capability of supporting and maintaining a balanced, integrated, adaptive community having species composition, diversity and functional organization comparable to that of natural habitat of the region" (Karr and Dudley 1981).

Methods

Field work was conducted by Montana Water Quality Division personnel on 3 August, 1990 and again on 3 August 1993. Aquatic macroinvertebrates were collected and habitat conditions assessed at three locations. Sites were designated as: at Wildlife refuge (lower reach), near Illinois Bench Road Bridge (middle reach) and below National Forest Land (upper reach). Macroinvertebrates were collected using standard traveling kick-net methods (Bukantis 1995). In 1990, a single macroinvertebrate sample was collected from each reach while two samples were obtained from each reach in 1993. Habitat parameters were evaluated using a habitat assessment field sheet.

Laboratory and data analyses were contracted to McGuire Consulting. Techniques described in the Montana RBP guidelines (Bukantis 1995) were used for both habitat and biological assessments.

Habitat was evaluated using 9 parameters in 1990 and 14 parameters in 1993 (Table 1). To allow comparisons between years, parameters were categorized as primary (instream habitat), secondary (channel morphology) or tertiary (banks and riparian). An overall habitat score was calculated by summing mean scores for primary, secondary, and tertiary habitat parameters. Final scores had a possible range of 0 to 45. For graphic representation, scores were expressed as a percentage of the maximum possible score. Total scores for the nine parameters evaluated both years were also calculated.

The 1993 macroinvertebrate samples were sorted using RBP III techniques (Plafkin et al. 1989) to provide approximately 300 organism subsamples. Organisms were enumerated and identified to the lowest practical taxonomic level, usually genus or species. Tolerance values and functional designations used in metric calculations were those recommended by Bukantis (1995).

The original 1990 analysis (Wisseman 1992) was based on subsamples contained between 402 and 681 organisms. To allow comparisons between years, the 1990 data were standardized to 300 organism samples. The relative abundance of each taxon in the original sample was used to determine the number of individuals of that taxon that would be included in a 300 organism subsample. For each taxon, the number included in the subsample was rounded down to a whole number and remaining fractions were added to the total of the next taxon. This allowed for the possibility of very rare taxa being included in the subsample. Metric values were then recalculated for the 1990 data.

RBP assessments provided numerical estimates of biological integrity. Selected metrics were compared to reference values and assigned scores ranging from 0 (severely impaired) to 6 (nonimpaired). The combined score of all metrics was expressed as a percentage of the maximum possible score and used as an estimate of biointegrity.

Assessments were made using two sets of criteria. The first assessment incorporated eight metrics: Taxa richness, EPT richness, Biotic index, % dominant taxon, % Collectors, % Scrapers and Shredders, % Hydropsychinae of Trichoptera, and % EPT. These metrics and the criteria used to assign metric scores (Table 2) represent the most recent RBP reference for Montana valley and foothill streams (McGuire 1995). This standardized characterization provided a general assessment of biological condition that is comparable with other streams in the valley and foothills ecoregion.

The second assessment provided a more discriminating evaluation of relative conditions within the study area. This analysis incorporated eight metrics that were considered the most appropriate for Threemile Creek. For this assessment, the % Hydropsychinae of Trichoptera metric was replaced by the percentage of the community represented by potentially multivoline species. The other seven metrics were common to both RBP assessments. Each of these metrics was compared with an internally derived reference which represented the highest (best) value for each metric among the nine samples from Threemile Creek (Table 3). Scoring criteria for this assessment were based on percent comparability to the reference value (adapted from McGuire 1994). Impairment classifications (Table 4) for both assessments were from Plafkin et al. (1989).

Results and Discussion

Habitat Assessment

Overall habitat condition improved in all three reaches from 1990 to 1993 (Figure 1). The greatest improvement was in the lower reach (Wildlife refuge) were percentage habitat scores increased from 44% in 1990 to 59% in 1993. In this reach, overall habitat condition improved from marginal in 1990 to sub-optimal in 1993. The additional metrics evaluated in 1993 accounted for some of the improvement between years; however, higher scores were recorded in 1993 for seven of the nine parameters evaluated both years (Table 1). Based on these nine metrics, habitat condition improved from 44% in 1990 to 50% in 1993. Reduced embeddedness and increased substrate stability were the most notable improvements between years.

In the middle reach (Illinois Bench Rd), overall habitat condition was considered sub-optimal during both years. Based on average scores for three levels of habitat categories, habitat condition improved from 62% in 1990 to 69% in 1993. The additional metrics incorporated into the 1993 evaluation accounted for all of the improvement between years (Table 1). Overall habitat scores were virtually unchanged between years when only the nine common metrics were considered. Benthic substrate, a primary habitat parameter, was considered less diverse in 1993 than in 1990.

During both years, habitat quality was highest in the upstream reach (below the National Forest). Habitat was considered near optimal in this reach with scores of 76% in 1990 and 81% in 1993. Scores for each year were identical using the two assessment methods. Interestingly, the scores of all three primary (instream) parameters declined in 1993 (Table 1). These reductions were offset by higher scores for all six secondary and tertiary parameters.

Macroinvertebrate-based Bioassessments

The 1993 macroinvertebrate data and the revised 1990 data are presented in Appendix A.

Foothill and Valley Reference Assessment

This analysis provided general characterizations of biological integrity that can be compared with other foothill and valley streams in Montana.

Using the most recent reference for Montana Valley and Foothills streams (Table 2), biointegrity in Threemile Creek ranged from moderately impaired to nonimpaired (Table 5). In 1990, the upstream reach (below National Forest) was nonimpaired, the middle reach (Illinois Bench Rd) was slightly impaired, and the lower reach (Wildlife refuge) was moderately impaired. These general impairment classifications were unchanged from Wisseman's (1992) original analysis of the 1990 data which employed different subsample sizes, metrics and scoring criteria than this update.

From 1990 to 1993, biointegrity improved from moderately impaired (50%) to slightly impaired (76%) in the Wildlife refuge reach and from slightly impaired (67%) to nonimpaired (85%) in the Illinois Bench Rd. reach (Table 5). Biological integrity appeared to be nonimpaired in the upstream reach of Threemile Creek during both years. However, biointegrity estimates declined from 92% in 1990 to 80% in 1993. This analysis indicated that during 1990, biointegrity was slightly higher in the Illinois Bench Rd. reach than in the reach immediately below the National Forest.

Threemile Creek Internal Reference Assessment

While not directly comparable to other streams, this assessment provided a more discriminating evaluation of conditions within Threemile Creek than did the Valley and Foothills reference. This analysis used the value representing the highest biointegrity (highest or lowest value) among Threemile Creek samples as a reference for each metric (Table 3) and the suite of metrics provided a more sensitive comparison of relative conditions within the study area. The upstream reach provided most of the reference values used in this analysis (four from the 1990 sample and one from a 1993 sample). The remaining reference values were from the lower reach in 1990 (one) and 1993 (two).

Biological assessments were generally in agreement with the habitat assessments (Figure 1). Compared with the internal reference, biointegrity scores ranged from 25% to 96% (Table 6). During both years, biological integrity was highest in the upstream (below USFS) reach and declined in each downstream reach. Biointegrity improved substantially in the middle and lower reaches of Threemile Creek from 1990 to 1993.

Biointegrity was lowest in the Wildlife refuge reach during both years; but, improved from 25% in 1990 to 55% in 1993. Six of eight metrics indicated higher biointegrity in 1993 (Table 6). The improved biointegrity score in 1993 reflected a dramatic shift in community composition, diversity and function between years. The sediment tolerant mayfly, *Tricorythodes*, comprised 61% of the organisms collected in the lower reach during 1990. In contrast, the most abundant macroinvertebrate in 1993 was the intolerant caddisfly, *Glossosoma*, which comprised only 28% of the collections. The percentage of the community comprised of scrapers increased approximately seven fold between years and EPT richness increased from 6 in 1990 to 11 in 1993. Improved biointegrity in 1993 appeared attributable to changes in substrate characteristics between years. In particular, more stable instream substrates and reduced embeddedness may have had a positive influence on the benthic community.

Biointegrity also improved in the middle reach (Illinois Bench Rd) from 1990 to 1993. Biological integrity was moderately impaired in 1990 (33%) but only slightly impaired in 1993 (65%). In 1990, Chironomidae dominated the fauna while, in 1993, caddisflies were the most abundant macroinvertebrates. The changes in community composition and function were reflected in higher scores of five metrics (Table 6).

Biointegrity was highest in the upstream reach (below National Forest) during both years; however, biological integrity declined from 96% in 1990 to 72% in 1993. The lower biological integrity estimate in 1993 resulted from a shift in community composition and reduced diversity compared with 1990. In 1990, no taxa accounted for more than 14% of the total fauna and beetles, mayflies, and caddisflies each comprised approximately 25% of the benthic assemblage. In contrast, community composition was less even in 1993 when the riffle beetle, *Heterlimnius*, accounted for 36% of the fauna.

The diversity, stability and embeddedness of instream substrates appeared to be important factors limiting biological integrity in all reaches of Threemile Creek and changes in benthic assemblages between years appeared to be associated with instream habitat quality. As noted in the habitat assessment (Table 1), benthic substrate diversity and embeddedness in the upstream reach were rated lower in 1993 than in 1990 while benthic substrate quality and biointegrity improved in the lower reach during 1993 relative to 1990.

Table 1. Stream and riparian habitat assessment.

Stream:	Threemile Creek					
Location:	Wildlife refuge		Illinois Bench Rd		below USFS	
Date:	Aug-90	Aug-93	Aug-90	Aug-93	Aug-90	Aug-93
Evaluator:	MWQB	Bukantis	MWQB	Bukantis	MWQB	Bukantis
Parameter						
P riffle development		18.5		20		20
P substrate	9	10	15	11	20	14
P embeddedness	7	11	8	11	17	14
P discharge/vel&depth	15	10	15	15	16	15
P canopy cover		5		18		14
S channel alteration	2	4	8	4	9	13
S substrate stability	3	6	6	7	10	11
S pool/riffle	8	11	10	12	9	15
S flow status		15		15		15
T bank stability	3	4	6	5	5	9
T bank cover stability	8	7	10	8	9	10
T streamside cover	4	5	6	8	7	8
T riparian width		10		6		4
Average metric scores						
primary (20 max)	10.3	10.9	12.7	15.0	17.7	15.4
secondary (15 max)	4.3	9.0	8.0	9.5	9.3	13.5
tertiary (10 max)	5.0	6.5	7.3	6.8	7.0	7.8
total (45 max)	20	26	28	31	34	37
percentage	44%	59%	62%	69%	76%	81%
Cumulative scores						
9 metrics (135 max)	59	68	84	81	102	109
13 metrics (200 max)		117		140		162
percentage (9 metrics)	44%	50%	62%	60%	76%	81%
percentage (13 metrics)		58%		70%		81%

Categories: Optimal >81%, Sub-optimal 75 - 56%, Marginal 49 - 29%, Poor <23%.

Table 2. Metrics and scoring criteria for 300 organism RBP kick samples foothill and valley streams in Montana.

Foothill & Valley	Scoring Criteria			
metric	6	4	2	0
Taxa richness	>28	28-21	21-14	<14
EPT richness	>14	14-13	12 - 11	<11
Biotic index	<4	4 - 5	5 - 6	>6
% dominant taxon	<30	30-40	40-50	>50
% Collector-FFG	<60	60-75	75-90	>90
% Scrapers+Shredders	>30	30-20	20-10	<10
% Hydropsychinae of Trich.	<75	75-85	85-95	>95
% EPT	>60	60-45	45-30	<30

Table 3. Internal refernce values for Threemile Creek and Criteria for assigning scores to metrics based on percent comparability to reference values (adapted from McGuire 1992).

	Threemile	Scoring Criteria				
metric	Reference	6	4	2	0	*
Taxa richness	42	>80%	80-60%	60-40%	<40%	a
EPT richness	25	>90%	90-80%	80-70%	<70%	a
Biotic index	2.3	>85%	85-70%	70-50%	<50%	b
% dominant taxon	14	>60%	60-45%	45-30%	<30%	b
% Collector-FFG	51	>80%	80-70%	70-60%	<60%	b
% Scraper+Shredder	39	>80%	80-60%	60-40%	<40%	a
% EPT	69	>75%	75-50%	50-25%	<25%	a
% multivoltine	12	>40%	40-30%	30- 20%	<20%	b

Internal reference values are the "best" values among Threemile Creek samples.
* a = score is ratio of study site to reference site X 100.
* b = score is ratio of reference site to study site X 100.

Table 4. Criteria for the assessment of biologically significant environmental degradation (Plafkin et al 1989).

% comp. to reference	Classification
>83%	nonimpaired
54-79%	slightly impaired
21-50%	moderately impaired
<17%	severely impaired

Table 5. Metric values and bioassessments for Threemile Creek, Montana during August 1990 and 1993: standard Foothill and Valley reference (Table 2).

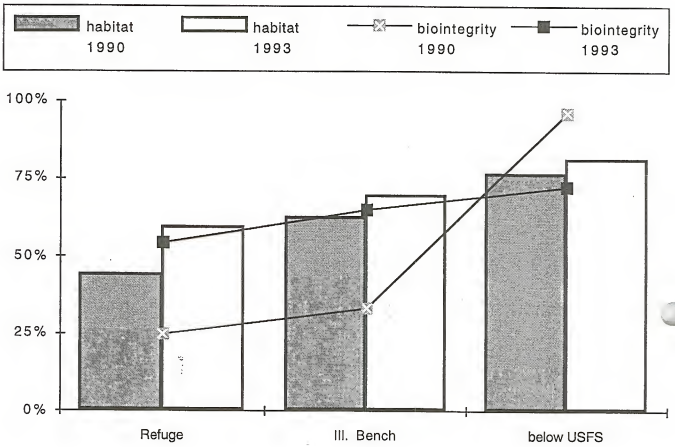
	location:	Wildlife refuge			Illinois Bench Rd			below Nat. Forest		
	date:	8/90	8/93	8/93	8/93	8/93	8/93	8/90	8/93	8/93
metric	sample ID:	RBP1	1.1	1.2	RBP2	2.1	2.2	RBP3	3.1	3.2
Taxa richness		24	26	22	32	31	31	42	38	34
EPT richness		6	12	10	15	13	16	25	23	20
Biotic index		4.4	3.4	4.0	4.7	3.6	3.0	2.4	2.3	2.4
% dominant taxon		61	32	25	22	23	30	14	39	34
% Collector-FFG		82	51	64	80	60	52	60	74	71
% Scrapers + Shredders		14	39	31	19	29	38	28	19	23
% Hydropsychinae of Trich.		0	1	1	20	0	0	0	3	0
% EPT		69	56	47	28	41	50	61	45	46
								metric score		
Taxa richness		4	4	4	6	6	6	6	6	6
EPT richness		0	2	0	6	4	6	6	6	6
Biotic index		4	6	5	4	6	6	6	6	6
% dominant taxon		0	4	6	6	6	4	6	4	4
% Collector-FFG		2	6	4	2	4	6	4	4	4
% Scrapers + Shredders		2	6	6	2	4	6	4	2	4
% Hydropsychinae of Trich.		6	6	6	6	6	6	6	6	6
% EPT		6	4	4	0	2	4	6	3	4
total score		24	38	35	32	38	44	44	37	40
% of reference		50%	79%	73%	67%	79%	92%	92%	77%	83%
classification*		MOD	SLI	SLI	SLI	SLI	NON	NON	SLI	NON

* classifications: (NON) nonimpaired, (SLI) slightly impaired, (MOD) moderately impaired, (SEV) severely impaired

Table 6. Metric values, percentage of reference, and bioassessments for Threemile Creek, Montana during August 1990 and 1993 (composite internal reference- Table 3).

	Wildlife refuge			Illinois Bench Rd			below Nat. Forest		
	8/90	8/93	8/93	8/93	8/93	8/93	8/90	8/93	8/93
metric	RBP1	1.1	1.2	RBP2	2.1	2.2	RBP3	3.1	3.2
Taxa richness	24	26	22	32	31	31	42	38	34
EPT richness	6	12	10	15	13	16	25	23	20
Biotic index	4.4	3.4	4.0	4.7	3.6	3.0	2.4	2.3	2.4
% dominant taxon	61	32	25	22	23	30	14	39	34
% Collector-FFG	82	51	64	80	60	52	60	74	71
% Scrapers + Shredders	14	39	31	19	29	38	28	19	23
% EPT	69	56	47	28	41	50	61	45	46
% Multivoltine	82	31	45	68	31	31	12	12	16
% of reference									
Taxa richness	57	62	52	76	74	74	100	90	81
EPT richness	24	48	40	60	52	64	100	92	80
Biotic index	52	67	58	49	64	77	96	100	96
% dominant taxon	23	44	56	64	61	47	100	33	38
% Collector-FFG	62	100	80	64	85	98	85	69	72
% Scrapers + Shredders	36	100	79	49	74	97	72	49	59
% EPT	100	81	68	41	59	72	88	65	67
% Multivoltine	15	39	27	18	39	39	100	100	75
metric score									
Taxa richness	2	4	2	4	4	4	6	6	6
EPT richness	0	0	0	0	0	0	6	6	3
Biotic index	2	2	2	0	2	4	6	6	6
% dominant taxon	0	2	4	6	6	4	6	2	2
% Collector-FFG	2	6	4	2	6	6	6	2	4
% Scrapers + Shredders	0	6	4	2	4	6	4	2	4
% EPT	6	6	4	2	4	4	6	4	4
% Multivoltine	0	4	2	0	4	4	6	6	6
total score	12	30	22	16	30	32	46	34	35
% of reference	25%	63%	46%	33%	63%	67%	96%	71%	73%
classification	MOD	SLI	MOD	MOD	SLI	SLI	NON	SLI	SLI

Figure 1. Habitat and biological integrity in Threemile Creek during August of 1990 and 1993.



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APPENDIX A:

AQUATIC MACROINVERTEBRATE DATA
Threemile Creek
August 1990 and August, 1993

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AQUATIC MACROINVERTEBRATE DATA
Threemile Creek
August 1990 and August, 1993

AQUATIC MACROINVERTEBRATE DATA - RBP kick samples (standardized to 300 organism
Threemile Creek - Aug 3, 1990

sample:	RBP1	RBP2	RBP 3
Taxon			
COLEOPTERA			
Heterlimnius sp.	0	0	41
Lara avara	0	4	6
Narpus concolor	23	0	1
Optioservus spp.	0	24	23
Zaitzevia parvula	2	8	0
Hydrophilidae	5	0	0
Dytiscidae	0	0	1
DIPTERA			
Diamesa sp.	0	2	0
Pagastia sp.	5	21	0
Potthastia sp.	1	0	0
Brillia sp.	0	2	0
Corynoneura sp.	0	1	0
Cricotopus sp.	3	0	2
Eukiefferiella spp.	5	25	4
Nanocladius sp.	1	0	0
Orthocladius sp.	12	65	3
Parametriocnemus sp.	0	1	0
Parakiefferiella sp.	0	0	1
Synorthocladius sp.	1	0	0
Thienemanniella sp.	1	1	0
Tvetenia sp.	3	19	6
Demicryptochironomus sp.	0	1	0
Polypedilum sp.	0	0	1
Saetheria sp.	3	0	0
Micropsectra sp.	3	8	0
Tanytarsus sp.	1	9	0
Rheotanytarsus sp.	1	0	1
Dicranota sp.	3	0	0
Glutops sp.	0	0	2
Ceratopogoninae	0	0	1
Simulium spp. (Eusimulium)	0	22	0
EPHEMEROPTERA			
Baetis tricaudatus	3	9	6
Diphetor hageni	0	1	0
Acentrella insignificans	0	1	0
Attenella margarita	0	1	0
Drunella coloradensis	0	0	28

AQUATIC MACROINVERTEBRATE DATA - RBP kick samples (standardized to 300 organism
Threemile Creek - Aug 3, 1990

sample:	RBP1	RBP2	RBP 3
Taxon			
Drunella doddsi	0	0	4
Drunella grandis	0	0	2
Serratella sp.	0	0	16
Cinygmula sp.	0	0	16
Epeorus albertae	0	0	1
Nixe sp.	14	15	0
Tricorythodes sp.	181	9	0
Paraleptophlebia sp.	0	0	1
PLECOPTERA			
Chloroperlinae	0	0	2
Malenka sp.	0	4	4
Zapada cinctipes	0	0	9
Yoraperla sp.	0	0	2
Pteronarcella sp.	6	11	0
Claassinia sabulosa	0	3	0
Doroneuria sp.	0	0	3
Megarcys sp.	0	0	3
Setvena	0	1	0
Skwala sp.	2	0	0
TRICHOPTERA			
Hydropsyche spp.	0	6	0
Arctopsyche sp.	0	0	10
Hydroptila sp.	1	4	0
Apatania sp.	0	0	22
Psychoglypha sp.	0	0	1
Neophylax sp.	0	3	3
Agapetus sp.	0	0	1
Glossosoma sp.	0	11	4
Brachycentrus americanus	0	6	3
Micrasema sp.	0	0	9
Dolophilodes sp.	0	0	18
Rhyacophila betteni gp.	0	0	4
Rhyacophila brunnea gp.	0	0	10
ANNELIDA			
Lumbricidae	0	0	14
Tubificidae	20	2	0

AQUATIC MACROINVERTEBRATE DATA - RBP kick samples (standardized to 300 organisms)
Threemile Creek - Aug 3, 1990

sample:	RBP1	RBP2	RBP 3
Taxon			
MOLLUSCA			
Sphaeriidae	0	0	1
OTHER			
Turbellaria	0	0	10
data from Wisseman (1992) as modified by McGuire			
TOTAL ORGANISMS	300	300	300
TAXA RICHNESS	24	32	42
EPT RICHNESS	6	15	25
BIOTIC INDEX	4.40	4.71	2.36
% DOMINANT TAXON	61%	22%	14%
% EPT	69%	28%	61%
% COLLECTORS (g+f)	82%	80%	60%
% SCRAPERS + SHREDDERS	14%	19%	28%
% Hydropsychinae of TRICH	0%	20%	0%
METALS TOLERANCE INDEX	4.01	4.74	2.22
% Baetidae of EPHEM.	2%	31%	8%
SHANNON DIVERSITY	2.46	4.14	4.60
EPT/(EPT + Chironomidae)	0.84	0.35	0.91
HBI- CTQa	101	92	55
% COLEOPTERA	10%	12%	24%
% DIPTERA	14%	59%	7%
% CHIRONOMIDAE	13%	52%	6%
% EPHEMEROPTERA	66%	12%	25%
% PLECOPTERA	3%	6%	8%
% TRICHOPTERA	0%	10%	28%
% multivoltine	82%	68%	12%
% univoltine	18%	31%	87%
% semivoltine	0%	1%	1%
FFG	% RA	% RA	% RA
% FILTERERS	1%	12%	10%
% COLLECTOR-GATHERERS	82%	68%	50%
% SHREDDERS	10%	7%	10%
% SCRAPERS	5%	12%	18%
% PREDATORS	3%	1%	12%
Scraper/(Scraper+Filterer)	88%	49%	64%

AQUATIC MACROINVERTEBRATE DATA - RBP kick samples (~300 organism subsamples)
Threemile Creek @ Wildlife Refuge - Aug 8, 1993

sample:	1.1		1.2		Cum
Taxon	#	% RA	#	% RA	% RA
COLEOPTERA					
Optioservus spp.	48	15.4%	56	17.0%	16.2%
Zaitzevia parvula	14	4.5%	8	2.4%	3.4%
Dytiscidae	0	0.0%	1	0.3%	0.2%
DIPTERA					
Pagastia sp.	6	1.9%	28	8.5%	5.3%
Cardiocladius sp.	1	0.3%	0	0.0%	0.2%
Cricotopus sp.	1	0.3%	5	1.5%	0.9%
Eukiefferiella spp.	6	1.9%	10	3.0%	2.5%
Parametriocnemus sp.	0	0.0%	2	0.6%	0.3%
Thienemanniella sp.	1	0.3%	0	0.0%	0.2%
Tvetenia sp.	23	7.4%	15	4.6%	5.9%
Phaenopsectra sp.	1	0.3%	0	0.0%	0.2%
Tanytarsus sp.	0	0.0%	2	0.6%	0.3%
Dicranota sp.	8	2.6%	5	1.5%	2.0%
Simulium spp. (Eusimulium)	3	1.0%	1	0.3%	0.6%
EPHEMEROPTERA					
Baetis tricaudatus	28	9.0%	31	9.4%	9.2%
Baetis punctiventris	0	0.0%	1	0.3%	0.2%
Nixe sp.	19	6.1%	14	4.3%	5.1%
Tricorythodes sp.	3	1.0%	9	2.7%	1.9%
PLECOPTERA					
Pteronarcella sp.	2	0.6%	5	1.5%	1.1%
Claassinia sabulosa	3	1.0%	1	0.3%	0.6%
Hesperoperla pacifica	2	0.6%	0	0.0%	0.3%
Isoperla sp.	3	1.0%	1	0.3%	0.6%
Isogenoides sp.	2	0.6%	0	0.0%	0.3%
Skwala sp.	10	3.2%	8	2.4%	2.8%
TRICHOPTERA					
Ceratopsyche spp.	1	0.3%	1	0.3%	0.3%
Glossosoma sp.	100	32.1%	82	24.9%	28.4%
Rhyacophila angelita gp.	1	0.3%	0	0.0%	0.2%
ANNELIDA					
Tubificidae	24	7.7%	43	13.1%	10.5%

AQUATIC MACROINVERTEBRATE DATA - RBP kick samples (~300 organism subsamples)
Threemile Creek @ Wildlife Refuge - Aug 8, 1993

sample:	1.1		1.2		Cum
Taxon	#	% RA	#	% RA	% RA
CRUSTACEA					
Decapoda	1	0.3%	0	0.0%	0.2%
Hyalella azteca	1	0.3%	0	0.0%	0.2%
% of sample used:	37%		50%		Mean
TOTAL ORGANISMS	312		329		321
TAXA RICHNESS	26		22		24.0
EPT RICHNESS	12		10		11.0
BIOTIC INDEX	3.38		3.98		3.68
% DOMINANT TAXON	32%		25%		28%
% EPT	56%		47%		51%
% COLLECTORS (g+f)	51%		64%		58%
% SCRAPERS + SHREDDERS	39%		31%		35%
% Hydropsychinae of TRICH	1%		1%		1%
METALS TOLERANCE INDEX	3.68		4.50		4.09
% Baetidae of EPHEM.	56%		58%		57%
SHANNON DIVERSITY	3.39		3.41		3.40
EPT/(EPT + Chironomidae)	0.82		0.71		0.76
HBI- CTQa	65		75		70
% COLEOPTERA	20%		20%		20%
% DIPTERA	16%		21%		18%
% CHIRONOMIDAE	13%		19%		16%
% EPHEMEROPTERA	16%		17%		16%
% PLECOPTERA	7%		5%		6%
% TRICHOPTERA	33%		25%		29%
% multivoltine	31%		45%		38%
% univoltine	67%		55%		61%
% semivoltine	2%		0%		1%
FFG	% RA	# taxa	% RA	# taxa	%RA
% FILTERERS	1%	2	1%	3	1%
% COLLECTOR-GATHERERS	50%	12	63%	11	57%
% SHREDDERS	1%	2	2%	1	1%
% SCRAPERS	38%	2	29%	2	34%
% PREDATORS	10%	8	5%	5	7%
Scraper/(Scraper+Filterer)	97%		96%		96%

AQUATIC MACROINVERTEBRATE DATA - RBP kick samples (~300 organism subsamples)
Threemile Creek nr. Illinois Bench Rd - Aug 8, 1993

sample:	2.1		2.2		Cum
Taxon	#	% RA		% RA	% RA
COLEOPTERA					
Cleptelmis ornata	5	1.8%	4	1.5%	1.6%
Heterlimnius sp.	1	0.4%	0	0.0%	0.2%
Narpus concolor	1	0.4%	0	0.0%	0.2%
Optioservus spp.	64	22.9%	31	11.3%	17.1%
Zaitzevia parvula	18	6.4%	22	8.0%	7.2%
DIPTERA					
Pagastia sp.	17	6.1%	11	4.0%	5.0%
Brillia sp.	0	0.0%	1	0.4%	0.2%
Cardiocladius sp.	10	3.6%	3	1.1%	2.3%
Cricotopus sp.	7	2.5%	5	1.8%	2.2%
Eukiefferiella spp.	16	5.7%	22	8.0%	6.8%
Orthocladius sp.	8	2.9%	1	0.4%	1.6%
Parametriocnemus sp.	0	0.0%	1	0.4%	0.2%
Synorthocladius sp.	1	0.4%	0	0.0%	0.2%
Tvetenia sp.	3	1.1%	11	4.0%	2.5%
Micropsectra sp.	3	1.1%	14	5.1%	3.1%
Tanytarsus sp.	1	0.4%	0	0.0%	0.2%
Antocha sp.	0	0.0%	1	0.4%	0.2%
Dicranota sp.	3	1.1%	6	2.2%	1.6%
Hexatoma sp.	1	0.4%	0	0.0%	0.2%
Chelifera sp.	1	0.4%	0	0.0%	0.2%
Simulium spp. (Eusimulium)	4	1.4%	4	1.5%	1.4%
EPHEMEROPTERA					
Baetis tricaudatus	17	6.1%	11	4.0%	5.0%
Diphetor hageni	0	0.0%	1	0.4%	0.2%
Acentrella insignificans	0	0.0%	1	0.4%	0.2%
Epeorus albertae	6	2.1%	3	1.1%	1.6%
Nixe sp.	5	1.8%	1	0.4%	1.1%
Paraleptophlebia sp.	0	0.0%	1	0.4%	0.2%
PLECOPTERA					
Malenka sp.	4	1.4%	8	2.9%	2.2%
Pteronarcella sp.	6	2.1%	2	0.7%	1.4%
Claassinia sabulosa	11	3.9%	10	3.6%	3.8%
Hesperoperla pacifica	2	0.7%	0	0.0%	0.4%
Skwala sp.	1	0.4%	3	1.1%	0.7%

AQUATIC MACROINVERTEBRATE DATA - RBP kick samples (~300 organism subsamples)
Threemile Creek nr. Illinois Bench Rd - Aug 8, 1993

sample:	2.1		2.2		Cum
Taxon	#	% RA		% RA	% RA
TRICHOPTERA					
Arctopsyche sp.	3	1.1%	1	0.4%	0.7%
Neophylax sp.	2	0.7%	4	1.5%	1.1%
Glossosoma sp.	45	16.1%	82	29.8%	22.9%
Brachycentrus americanus	11	3.9%	4	1.5%	2.7%
Rhyacophila angelita gp.	0	0.0%	1	0.4%	0.2%
Rhyacophila brunnea gp.	3	1.1%	5	1.8%	1.4%
% of sample used:	25%		50%		Mean
TOTAL ORGANISMS	280		275		278
TAXA RICHNESS	31		31		31.0
EPT RICHNESS	13		16		14.5
BIOTIC INDEX	3.56		3.00		3.28
% DOMINANT TAXON	23%		30%		26%
% EPT	41%		50%		46%
% COLLECTORS (g+f)	60%		52%		56%
% SCRAPERS + SHREDDERS	29%		38%		33%
% Hydropsychinae of TRICH	0%		0%		0%
METALS TOLERANCE INDEX	4.48		3.78		4.13
% Baetidae of EPHEM.	61%		72%		66%
SHANNON DIVERSITY	3.99		3.80		3.89
EPT/(EPT + Chironomidae)	0.64		0.67		0.65
HBI- CTQa	73		65		69
% COLEOPTERA	32%		21%		26%
% DIPTERA	27%		29%		28%
% CHIRONOMIDAE	24%		25%		24%
% EPHEMEROPTERA	10%		7%		8%
% PLECOPTERA	9%		8%		8%
% TRICHOPTERA	23%		35%		29%
% multivoltine	31%		31%		31%
% univoltine	64%		65%		65%
% semivoltine	5%		4%		4%
FFG	% RA	# taxa	% RA	# taxa	%RA
% FILTERERS	3%	3	2%	2	2%
% COLLECTOR-GATHERERS	57%	12	50%	15	53%
% SHREDDERS	4%	3	4%	3	4%
% SCRAPERS	25%	5	34%	5	29%
% PREDATORS	11%	8	10%	6	11%
Scraper/(Scraper+Filterer)	90%		95%		92%

AQUATIC MACROINVERTEBRATE DATA - RBP kick samples (~300 organism subsamples)
Threemile Creek below National Forest - Aug 8, 1993

sample:	3.1		3.2		Cum
Taxon	#	% RA		% RA	% RA
COLEOPTERA					
Cleptelmis ornata	1	0.3%	0	0.0%	0.2%
Heterlimnius sp.	120	38.7%	109	33.9%	36.2%
Lara avara	4	1.3%	2	0.6%	0.9%
Narpus concolor	1	0.3%	0	0.0%	0.2%
Optioservus spp.	12	3.9%	10	3.1%	3.5%
DIPTERA					
Pentaneura sp.	0	0.0%	1	0.3%	0.2%
Pagastia sp.	1	0.3%	1	0.3%	0.3%
Cricotopus sp.	1	0.3%	1	0.3%	0.3%
Cricotopus nostococladius	0	0.0%	1	0.3%	0.2%
Eukiefferiella spp.	1	0.3%	3	0.9%	0.6%
Orthocladius sp.	0	0.0%	1	0.3%	0.2%
Parametriocnemus sp.	0	0.0%	1	0.3%	0.2%
Tvetenia sp.	3	1.0%	10	3.1%	2.1%
Micropsectra sp.	14	4.5%	10	3.1%	3.8%
Glutops sp.	1	0.3%	0	0.0%	0.2%
Simulium spp. (Eusimulium)	1	0.3%	9	2.8%	1.6%
EPHEMEROPTERA					
Baetis tricaudatus	13	4.2%	10	3.1%	3.6%
Drunella coloradensis	20	6.5%	24	7.5%	7.0%
Drunella doddsi	4	1.3%	1	0.3%	0.8%
Drunella grandis	1	0.3%	0	0.0%	0.2%
Drunella spinifera	0	0.0%	1	0.3%	0.2%
Serratella sp.	17	5.5%	16	5.0%	5.2%
Cinygmula sp.	31	10.0%	49	15.2%	12.7%
Epeorus albertae	1	0.3%	1	0.3%	0.3%
Epeorus longimanus	2	0.6%	2	0.6%	0.6%
PLECOPTERA					
Chloroperlinae	3	1.0%	2	0.6%	0.8%
Malenka sp.	3	1.0%	0	0.0%	0.5%
Zapada cinctipes	1	0.3%	0	0.0%	0.2%
Yoraperla sp.	1	0.3%	1	0.3%	0.3%
Doroneuria sp.	4	1.3%	2	0.6%	0.9%
Megarcys sp.	3	1.0%	1	0.3%	0.6%

AQUATIC MACROINVERTEBRATE DATA - RBP kick samples (~300 organism subsamples)
Threemile Creek below National Forest - Aug 8, 1993

sample:	3.1		3.2		Cum
Taxon	#	% RA		% RA	% RA
TRICHOPTERA					
Ceratopsyche spp.	1	0.3%	0	0.0%	0.2%
Arctopsyche sp.	3	1.0%	1	0.3%	0.6%
Apatania sp.	1	0.3%	3	0.9%	0.6%
Neophylax sp.	1	0.3%	5	1.6%	0.9%
Agapetus sp.	0	0.0%	2	0.6%	0.3%
Brachycentrus americanus	1	0.3%	1	0.3%	0.3%
Micrasema sp.	8	2.6%	5	1.6%	2.1%
Dolophilodes sp.	13	4.2%	10	3.1%	3.6%
Rhyacophila angelita gp.	3	1.0%	0	0.0%	0.5%
Rhyacophila brunnea gp.	6	1.9%	10	3.1%	2.5%
ANNELIDA					
Lumbricidae	7	2.3%	14	4.3%	3.3%
Tubificidae	1	0.3%	0	0.0%	0.2%
OTHER					
Turbellaria	1	0.3%	2	0.6%	0.5%

AQUATIC MACROINVERTEBRATE DATA - RBP kick samples (~300 organism subsamples)
Threemile Creek below National Forest - Aug 8, 1993

sample:	3.1		3.2		Cum
Taxon	#	% RA		% RA	% RA
% of sample used:	90%		50%		Mean
TOTAL ORGANISMS	310		322		316
TAXA RICHNESS	38		35		36.5
EPT RICHNESS	23		20		21.5
BIOTIC INDEX	2.30		2.38		2.34
% DOMINANT TAXON	39%		34%		36%
% EPT	45%		46%		46%
% COLLECTORS (g+f)	74%		71%		73%
% SCRAPERS + SHREDDERS	19%		23%		21%
% Hydropsychinae of TRICH	3%		0%		1%
METALS TOLERANCE INDEX	2.16		2.14		2.15
% Baetidae of EPHEM.	15%		10%		12%
SHANNON DIVERSITY	3.62		3.63		3.62
EPT/(EPT + Chironomidae)	0.88		0.84		0.86
HBI- CTQa	70		70		70
% COLEOPTERA	45%		38%		41%
% DIPTERA	7%		12%		9%
% CHIRONOMIDAE	6%		9%		8%
% EPHEMEROPTERA	29%		32%		31%
% PLECOPTERA	5%		2%		3%
% TRICHOPTERA	12%		11%		12%
% multivoltine	12%		16%		14%
% univoltine	87%		84%		85%
% semivoltine	1%		1%		1%
FFG	% RA	# taxa	% RA	# taxa	%RA
% FILTERERS	6%	4	6%	3	6%
% COLLECTOR-GATHERERS	68%	14	65%	12	67%
% SHREDDERS	6%	6	3%	4	4%
% SCRAPERS	13%	7	20%	8	17%
% PREDATORS	7%	7	6%	7	6%
Scraper/(Scraper+Filterer)	69%		76%		73%